Activities of Japanese Steel Industry to Combat Global Warming
Report of “JISF’s Commitment to a Low Carbon Society”

February 2021
The Japan Iron and Steel Federation
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Japanese steel industry is supporting the Commitment to a Low Carbon Society by fighting global warming with the “three ecos” created during the Voluntary Action Plan along with COURSE50.

**Eco Process**

The target is a CO$_2$ emission reduction of 5 million tons by FY2020 vs. expected emissions for each production volume (BAU) by fully implementing state-of-the-art technologies. Of this reduction, JISF prioritizes 3 million tons of reduction arising from energy conservation and other voluntary actions by steelmakers. For waste plastics and other recycled materials, the emission reduction includes only a decrease resulting from the increase in the volume of these materials collected vs. the FY2005 level.

**Eco Solution**

Contribute worldwide by transferring the world’s most advanced energy-saving technologies to other countries (especially to developing countries) and increasing the use of these technologies. (Estimated emission reduction contribution of about 70 million tons in FY2020)

**Eco Product**

By supplying the high-performance steel that is essential to create a low-carbon society, contribute to lowering emissions when finished products using this steel are used (Estimated emission reduction contribution of about 34 million tons in FY2020)

**Development of CO2 Ultimate Reduction System for Cool Earth 50 (COURSE50)**

Cut CO$_2$ emissions from production processes about 30% by using hydrogen for iron ore reduction and collecting CO$_2$ from blast furnace gas. The first production unit is to begin operations by about 2030*. The goal is a widespread use of these processes by about 2050 in line with the timing of updates of existing blast furnace facilities.

* Assumes establishment of economic basis for CO$_2$ storage infrastructure and creation of a practical unit using these processes.
1. Eco Process
On February 20, 2014, JISF became the first industry association in the world to receive ISO50001 certification (energy management system). This certification recognizes measures to combat global warming in the Voluntary Action Plan/Commitment to a Low Carbon Society as well as activities for conserving energy.
(Reference) Reexamination of Stance for Targets Established in FY2016

Eco Process **Before reexamination**
The target is a CO2 emission reduction of 5 million tons by FY2020 vs. expected emissions for each production volume (BAU) by fully implementing state-of-the-art technologies.

Interim- Review
1. Properly determine BAU by reflecting changes in steel production mix
2. Include actual emission reductions resulting from the use of waste plastics and other recycled materials

Eco Process **After reexamination**
The target is a CO2 emission reduction of 5 million tons by FY2020 vs. expected emissions for each production volume (BAU) by fully implementing state-of-the-art technologies. Of this reduction, JISF prioritizes 3 million tons of reduction arising from energy conservation and other voluntary actions by steelmakers. For waste plastics and other recycled materials, the emission reduction includes only a decrease resulting from the increase in the volume of these materials collected vs. the FY2005 level.
Calculation of BAU Emissions for FY 2019 Performance Evaluation

(1) Calculation of BAU Emission prior to adjustment

Calculated using the regression equation* and crude steel output

BAU regression equation: \( y = 1.271x + 0.511 \) (\( x = \) Crude steel output)

* The correlation function for crude steel output and \( \text{CO}_2 \) emissions was established based on the regression equation obtained by analyzing the correlation between crude steel output and \( \text{CO}_2 \) emission intensity for FY2005-FY2009 (using the FY2005 electricity coefficient every year).

FY2018 crude steel output (total for participating companies) = 94.87 million tons

**Adjustment FY2019 BAU emissions = 171.64 million tons of \( \text{CO}_2 \) (A)**

(2) Calculation of change in \( \text{CO}_2 \) emissions due to change in production mix

\( \text{CO}_2 \) conversion using changes in upstream (pig iron ratio) and downstream (product category mix) processes based on the RITE index

Upstream change volume: +3.52mn tons of \( \text{CO}_2 \)  
Downstream change volume: -1.51mn tons of \( \text{CO}_2 \)

**FY2019 change in \( \text{CO}_2 \) due to change in production mix (upstream and downstream): +2.01 mn tons of \( \text{CO}_2 \) (B)**

(3) Adjusted BAU Emissions

**FY2019 adjusted BAU Emissions = 173.64 million tons of \( \text{CO}_2 \) [(A) + (B)]**
(Reference) Reexamination of BAU by reflecting changes in steel production mix

- Up to FY2014, the JISF’s Commitment to a Low Carbon Society used evaluations with a BAU line (left graph) incorporating the assumption that the FY2005 production mix will not change.
- Currently, changes are taking place in the production mix. For example, as Japanese steelmakers move production to Southeast Asia and other overseas locations, the shift of some final production processes has raised the percentage of intermediate products (such as hot-rolled sheets). Also, the percentages of some finished products (such as galvanized sheets) are decreasing. Pig iron production has increased in proportion to these changes and CO₂ emissions are rising as a result.
- Incorporating these changes was not possible with the previous BAU line. Consequently, the change in CO₂ associated with the production mix change was calculated by using the production mix index produced by RITE (the RITE index). Starting in FY2015, emissions have been evaluated by using the adjusted BAU line, which incorporates the BAU line.

Until FY2014
Assumes no change in production mix from FY2005 level

Since FY2015
Adjusted to reflect production mix change since FY2005

* This target assumes that Japan’s crude steel output will be 120 million tons, with a variance of no more than 10 million tons.
* The colored sections of the graphs on this page show the range of production at companies participating in the Commitment to a Low Carbon Society when Japan’s crude steel output is between 110 million and 130 million tons.
(Reference) Changes in steel production mix

- When determining the RITE index, the total change in CO\textsubscript{2} emissions caused by a production mix change is evaluated by adding the changes in emissions associated with a change in the pig iron ratio for upstream processes and a change in the product mix for downstream processes.
- The BAU line uses a production mix that remains the same as in FY2005. As a result, it is possible to perform a proper evaluation with the BAU line in which the changes in the production mix are incorporated by shifting the line according to the changes.

### Pig Iron Ratio (Upstream processes)

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2018</th>
<th>2019</th>
<th>19 vs 05 (1,000t)</th>
<th>19 vs 05 (%)</th>
<th>19 vs 18 (1,000t)</th>
<th>19 vs 18 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude steel (1,000t)</td>
<td>112,718</td>
<td>102,886</td>
<td>98,426</td>
<td>▲ 14,292</td>
<td>▲ 12.7 %</td>
<td>▲ 4,460</td>
<td>▲ 4.3 %</td>
</tr>
<tr>
<td>BF-BOF (1,000t)</td>
<td>83,645</td>
<td>76,854</td>
<td>74,900</td>
<td>▲ 8,745</td>
<td>▲ 10.5 %</td>
<td>▲ 1,954</td>
<td>▲ 2.5 %</td>
</tr>
<tr>
<td>EAF (1,000t)</td>
<td>28,595</td>
<td>25,655</td>
<td>23,192</td>
<td>▲ 5,403</td>
<td>▲ 18.9 %</td>
<td>▲ 2,463</td>
<td>▲ 9.6 %</td>
</tr>
<tr>
<td>Pig iron (1,000t)</td>
<td>82,937</td>
<td>75,920</td>
<td>74,994</td>
<td>▲ 7,943</td>
<td>▲ 9.6 %</td>
<td>▲ 926</td>
<td>▲ 1.2 %</td>
</tr>
</tbody>
</table>

### CO\textsubscript{2} conversions using the RITE index to incorporate the above changes

- Upstream: + 3,520 t-CO\textsubscript{2}
- Downstream: ▲ 1,512 t-CO\textsubscript{2}
- Total: + 2,008 t-CO\textsubscript{2}

### Long and Flat Products Ratio (Downstream processes)

- In flat products, HRS (hot-rolled strips) increased and cold-rolled flat products and galvanized sheets decreased

<table>
<thead>
<tr>
<th>steel type</th>
<th>2005 ratio</th>
<th>2018 ratio</th>
<th>2019 ratio</th>
<th>19 vs 05 (%)</th>
<th>19 vs 18 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shape</td>
<td>7.5 %</td>
<td>6.9 %</td>
<td>6.5 %</td>
<td>▲ 1.0 %</td>
<td>▲ 0.4 %</td>
</tr>
<tr>
<td>Bar</td>
<td>12.3 %</td>
<td>10.3 %</td>
<td>10.0 %</td>
<td>▲ 2.3 %</td>
<td>▲ 0.3 %</td>
</tr>
<tr>
<td>total</td>
<td>23.5 %</td>
<td>20.4 %</td>
<td>19.7 %</td>
<td>▲ 3.8 %</td>
<td>▲ 0.7 %</td>
</tr>
<tr>
<td>Flat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plate</td>
<td>11.3 %</td>
<td>10.9 %</td>
<td>10.8 %</td>
<td>▲ 0.5 %</td>
<td>▲ 0.1 %</td>
</tr>
<tr>
<td>HRS</td>
<td>11.3 %</td>
<td>16.7 %</td>
<td>19.3 %</td>
<td>+ 8.0 %</td>
<td>+ 2.6 %</td>
</tr>
<tr>
<td>Cold-rolled flat products</td>
<td>8.6 %</td>
<td>8.0 %</td>
<td>7.7 %</td>
<td>▲ 0.9 %</td>
<td>▲ 0.3 %</td>
</tr>
<tr>
<td>Galvanized sheet</td>
<td>14.6 %</td>
<td>12.7 %</td>
<td>12.2 %</td>
<td>▲ 2.4 %</td>
<td>▲ 0.5 %</td>
</tr>
<tr>
<td>total</td>
<td>46.3 %</td>
<td>48.7 %</td>
<td>50.6 %</td>
<td>+ 4.3 %</td>
<td>+ 1.9 %</td>
</tr>
</tbody>
</table>
Crude steel is made by reducing natural resources to make pig iron or by using steel scrap that has already been reduced. The pig iron ratio is the amount of pig iron produced in relation to the production of crude steel (pig iron output divided by crude steel output). Variations in this ratio also affect unit CO₂ emissions.

To evaluate this effect properly, a primary coefficient is established that includes (1) comprehensive energy statistics, (2) IEA energy balance table, (3) environmental reports of steelmakers, (4) international peer-reviewed papers and other items.

The number obtained by using this primary coefficient is the upstream process index. The formula is: \( y \) (Upstream index) = 1.419 \times (Pig iron ratio) +0.70.

Changes in CO₂ emissions caused by changes in the pig iron ratio are calculated by multiplying the difference between the upstream process index for FY2005 and each subsequent year by crude steel output.

### Actual data (FY2005 and FY2019)

<table>
<thead>
<tr>
<th>Year</th>
<th>Pig iron ratio</th>
<th>Upstream process index</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY2005</td>
<td>0.736</td>
<td>1.743</td>
</tr>
<tr>
<td>FY2019</td>
<td>0.762</td>
<td>1.780</td>
</tr>
</tbody>
</table>

### Change in CO₂ emissions due to change in pig iron ratio (FY2018)

\[
(1.780-1.743) \times 94.87 \text{ mnt} = 352 \text{ mnt}
\]

⇒ Assessed as a 352 million ton increase in CO₂ emissions
**Summary of the Downstream Process Index**

Unit CO₂ emissions per ton of production* have been established for different shapes of ordinary steel and types of specialty steel, a total of 35 product categories, for which general statistics are accessible. Using FY2005 as the reference year, the change in CO₂ emissions caused by the change in the production mix in each year is then calculated. This calculation is performed as follows.

Meanwhile, up until the FY 2017 report, the total amount was calculated by multiplying the above-mentioned difference between the unit emission figure for FY 2005 and the same figure for the year under review by the amount of production of crude steel. However, changes in the downstream processes are changes in the mix of steel product categories. Therefore, starting from fiscal 2018 report, the amount computed by multiplying the amount of production of crude steel by the yield ratio of steel products to crude steel for FY 2005 (this is equivalent to the amount of production of steel products) is used to calculate the total amount.

A. The product mix ratio for each steel product in each year (Table 1) and unit CO₂ emissions (Table 2) are multiplied (Table 3).

B. All the numbers obtained from the step A are added (which yields a composite unit emission value-weighted for the production mix): 0.846 in FY2005 and 0.828 in FY2019 in the table below.

C. The total amount is calculated by multiplying the difference between the composite unit emission figure for the year under review and the same figure for the base year (FY 2005), which is obtained in step B, by the amount for the year under review that is computed by multiplying the amount of production of crude steel by the yield ratio of steel products to crude steel for FY 2005 (this is equivalent to the amount of production of steel products).

For FY2019: (0.828-0.846) x 94.87mnt x 0.907 = -1.51 mnt

*Unit CO₂ emissions for each steel product category for all years are based on the worldsteel LCI data collection. Averages for Japan calculated by using actual FY2014 data are used when available for these products. For products where there is no Japan average, unit emissions are estimated by using the relationship between unit emissions for steel for which Japan averages exist and selling prices (FY2010 export prices using trade statistics).
FY2019 Results of JISF’s Commitment to a Low Carbon Society

Progress toward targets *Totals for companies participating in the Commitment to a Low Carbon Society

- Crude steel production: 94.87 million tons (down 12.2% from FY05)
- BAU emissions for FY19 crude steel production: 173.64 million tons of CO₂
- CO₂ emissions (using FY05 electricity coefficient): 170.34 million tons of CO₂ (down 9.6% from FY05)
- Reduction vs. BAU: 3.30 million tons of CO₂ (0.30 million tons over achievement)

FY2019 Energy Consumption and CO₂ Emissions *Totals for companies participating in the Commitment to a Low Carbon Society

- Energy consumption: 2,070PJ (down 9.5% from FY05)
- CO₂ emissions (using electricity coefficient with FY18 credit): 172.61 million tons (down 8.4% from FY05)

Reference: Japanese steel industry total
(including not participating companies participating in the Commitment to a Low Carbon Society)

- Crude steel production: 98.43 million tons (down 12.7% from FY05)
- Energy consumption: 2,144PJ (down 9.2% from FY05)
- CO₂ emissions (using electricity coefficient with FY18 credit): 176.71 million tons (down 8.3% from FY05)

* Energy consumption and CO₂ emissions for the Japanese steel industry are estimates based on statistics for the use of petroleum and other energy sources.
Annual Trend of Energy Consumption and CO₂ Emissions

1. Eco Process

Total Energy Consumption

<table>
<thead>
<tr>
<th>Year (FY)</th>
<th>Crude steel (million ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>108</td>
</tr>
<tr>
<td>2005</td>
<td>113</td>
</tr>
<tr>
<td>2006</td>
<td>117</td>
</tr>
<tr>
<td>2007</td>
<td>101</td>
</tr>
<tr>
<td>2008</td>
<td>94</td>
</tr>
<tr>
<td>2009</td>
<td>103</td>
</tr>
<tr>
<td>2010</td>
<td>104</td>
</tr>
<tr>
<td>2011</td>
<td>108</td>
</tr>
<tr>
<td>2012</td>
<td>107</td>
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<td>2013</td>
<td>101</td>
</tr>
<tr>
<td>2014</td>
<td>101</td>
</tr>
<tr>
<td>2015</td>
<td>99</td>
</tr>
<tr>
<td>2016</td>
<td>95</td>
</tr>
</tbody>
</table>

Crude steel (million ton) 105

Unit Energy Consumption (FY1990 level=100)

<table>
<thead>
<tr>
<th>Year (FY)</th>
<th>Unit Energy Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>100.0</td>
</tr>
<tr>
<td>2005</td>
<td>89.7</td>
</tr>
<tr>
<td>2006</td>
<td>87.6</td>
</tr>
<tr>
<td>2007</td>
<td>87.3</td>
</tr>
<tr>
<td>2008</td>
<td>91.2</td>
</tr>
<tr>
<td>2009</td>
<td>90.7</td>
</tr>
<tr>
<td>2010</td>
<td>92.4</td>
</tr>
<tr>
<td>2011</td>
<td>91.9</td>
</tr>
<tr>
<td>2012</td>
<td>89.8</td>
</tr>
<tr>
<td>2013</td>
<td>90.2</td>
</tr>
<tr>
<td>2014</td>
<td>90.4</td>
</tr>
<tr>
<td>2015</td>
<td>90.3</td>
</tr>
<tr>
<td>2016</td>
<td>90.9</td>
</tr>
<tr>
<td>2017</td>
<td>92.6</td>
</tr>
<tr>
<td>2018</td>
<td>94.2</td>
</tr>
<tr>
<td>2019</td>
<td>94.2</td>
</tr>
</tbody>
</table>

CO₂ Emissions from Fuel Combustion (Incorporate improvement by emission credit)

<table>
<thead>
<tr>
<th>Year (FY)</th>
<th>Mt·CO₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>188.4</td>
</tr>
<tr>
<td>2005</td>
<td>191.6</td>
</tr>
<tr>
<td>2006</td>
<td>189.8</td>
</tr>
<tr>
<td>2007</td>
<td>187.2</td>
</tr>
<tr>
<td>2008</td>
<td>187.1</td>
</tr>
<tr>
<td>2009</td>
<td>194.4</td>
</tr>
<tr>
<td>2010</td>
<td>191.8</td>
</tr>
<tr>
<td>2011</td>
<td>184.1</td>
</tr>
<tr>
<td>2012</td>
<td>182.6</td>
</tr>
<tr>
<td>2013</td>
<td>177.4</td>
</tr>
<tr>
<td>2014</td>
<td>172.6</td>
</tr>
</tbody>
</table>

Crude steel (million ton) 105

Unit CO₂ Emissions (FY1990 level=100) (Incorporate improvement by emission credit)

<table>
<thead>
<tr>
<th>Year (FY)</th>
<th>Unit CO₂ Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>100.0</td>
</tr>
<tr>
<td>2005</td>
<td>90.2</td>
</tr>
<tr>
<td>2006</td>
<td>90.5</td>
</tr>
<tr>
<td>2007</td>
<td>90.1</td>
</tr>
<tr>
<td>2008</td>
<td>92.8</td>
</tr>
<tr>
<td>2009</td>
<td>92.7</td>
</tr>
<tr>
<td>2010</td>
<td>94.2</td>
</tr>
<tr>
<td>2011</td>
<td>92.7</td>
</tr>
<tr>
<td>2012</td>
<td>92.6</td>
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<tr>
<td>2013</td>
<td>92.7</td>
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<tr>
<td>2014</td>
<td>94.2</td>
</tr>
<tr>
<td>2015</td>
<td>92.7</td>
</tr>
<tr>
<td>2016</td>
<td>92.6</td>
</tr>
<tr>
<td>2017</td>
<td>92.7</td>
</tr>
<tr>
<td>2018</td>
<td>94.2</td>
</tr>
<tr>
<td>2019</td>
<td>94.2</td>
</tr>
</tbody>
</table>

*PJ is a petajoule (10¹⁵ joules). One joule is 0.23889 calories. 1PJ is equivalent to about 2.58 million kiloliters of crude oil.
Components of Changes in FY2019 CO₂ Emissions

- In FY2019, CO₂ emissions were 3.30 million tons below the BAU level. Energy and CO₂ conservation measures cut emissions by 3.03 million tons, aging bricks in coke ovens raised emissions by 0.84 million tons, and other measures cut emissions by 1.12 million tons. These figures do not include changes in CO₂ emissions caused by the use of waste plastic.

- FY2019 performance overachieved FY2020 target by 300,000 t-CO₂.

Progress toward 3 million ton CO₂ emission reduction due to energy conservation and other voluntary measures

- BAU emissions: 17,364
- Aging coke oven bricks: +84
- Energy/CO₂ conservation: ▲303
- Others: ▲112
- Actual emission FY18 (excl. waste plastic): 17,034.4
- Target volume: 17,064

Adjustment using RITE index (included 2.01 million tons of CO₂)

VS. BAU emissions -3.30Mt-CO₂ (excludes reduction by waste plastic use)

VS. Target -0.30Mt-CO₂

※FY2019 CO₂ emissions use the FY2005 electricity coefficient.
## Evaluation of FY2019 Performance

### 1. Progress with measures incorporated in the target

<table>
<thead>
<tr>
<th>Expected target</th>
<th>FY 2018</th>
<th>FY 2019</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Reductions from energy saving actions</td>
<td>-3.00Mt</td>
<td>-2.73Mt</td>
<td>-3.03Mt</td>
</tr>
<tr>
<td>• Higher coke oven efficiency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• More efficient power generation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• More energy conservation</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Thanks to renewal of in-house power generation facilities, etc., the amount of reduction increased from the FY 2018 actual amount.
- The expected amount of reduction, based on measures incorporated in the target, was achieved in FY 2019.

*Starting FY 2018, the CO\(_2\) reduction effects of projects for which energy conservation subsidies are granted (projects that contribute to improving unit fuel consumption, such as the use of regenerative burners) in relation to “more energy conservation” are quantified and recorded.

### 2. Factors affecting emissions that were unforeseen when targets were established

<table>
<thead>
<tr>
<th>Expected target</th>
<th>FY 2018</th>
<th>FY 2019</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aging coke oven bricks</td>
<td>—</td>
<td>+1.01Mt</td>
<td>+84Mt</td>
</tr>
<tr>
<td>• CO(_2) emissions increased due to deterioration of coke oven firebricks. This seems to be caused by the aged deterioration of the bricks and the effects of the Great East Japan Earthquake.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• There remain factors that increase CO(_2) emissions; however, JISF member companies have successively started renewing coke ovens, and as a result, the increase in the amount of CO(_2) emissions has declined for two years in a row.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other issues</td>
<td>—</td>
<td>-.42Mt</td>
<td>-1.12Mt</td>
</tr>
<tr>
<td>• It is difficult to pinpoint the causes of this decline. But it seems that energy conservation factors, such as operational efforts, surpassed energy waste factors.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• In FY 2018, energy consumption increased due to temporary troubles, etc., decreasing the amount of reduction; however, the trouble factors were removed in FY 2019, improving the amount of reduction (emissions declined by 96M tons in FY 2017).</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Total | — | +59Mt | -27Mt |

### 3. Progress toward targets (1+2)

<table>
<thead>
<tr>
<th>Expected target</th>
<th>FY 2018</th>
<th>FY 2019</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction vs. BAU</td>
<td>-3.00Mt</td>
<td>2.14Mt</td>
<td>-3.30Mt</td>
</tr>
<tr>
<td>• The reduction target compared to BAU emissions, including unexpected factors, was achieved as of FY 2019.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Changes in CO(_2) emissions caused by the use of waste plastic are not included.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 4. Progress with using waste plastics

<table>
<thead>
<tr>
<th>Expected target</th>
<th>FY 2018</th>
<th>FY 2019</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher waste plastic use</td>
<td>—</td>
<td>+14Mt</td>
<td>0</td>
</tr>
<tr>
<td>• The capacity to collect waste plastics in FY 2019 was equivalent to that in FY 2005, and therefore, there was no change in CO(_2) emissions in FY 2019.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The previous fiscal year’s report said that the amount of CO\(_2\) emissions in FY 2018 was 2.21 million tons lower than the BAU level. But this amount was changed in this report, partly because the unit calorific values and carbon emission factors have been revised by the government.*
JISF member companies have started replacing aging bricks in coke ovens, which is one cause of the increase in CO2 emissions. Improvements at 11 coke ovens were already completed during Phase I of the Commitment to a Low Carbon Society.

Although work has started, it will be impossible to solve all the issue of increasing CO2 emissions in 2020 because of the limited availability of workers (coke oven construction specialists) and the high cost of updates (tens of billions of yen for each oven).

### JISF Member Company Coke Oven Update Plans

(Company and newspaper announcements as of February 2020)

**1. Completed Updating Projects (11 ovens)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Steel works</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY2013</td>
<td>JFE Steel, West Japan Works, Kurashiki</td>
<td>About ¥15 billion</td>
</tr>
<tr>
<td>FY2015</td>
<td>JFE Steel, West Japan Works, Kurashiki</td>
<td>About ¥20 billion</td>
</tr>
<tr>
<td>FY2016</td>
<td>Nippon Steel, Kashima Works</td>
<td>About ¥18 billion</td>
</tr>
<tr>
<td></td>
<td>JFE Steel, East Japan Works, Chiba</td>
<td>About ¥11 billion</td>
</tr>
<tr>
<td></td>
<td>Nippon Steel, Kimitsu Works</td>
<td>About ¥29 billion</td>
</tr>
<tr>
<td>FY2017</td>
<td>JFE Steel, West Japan Works, Kurashiki</td>
<td>About ¥18.4 billion</td>
</tr>
<tr>
<td>FY2018</td>
<td>Nippon Steel, Kashima Works</td>
<td>About ¥31 billion</td>
</tr>
<tr>
<td></td>
<td>JFE Steel, East Japan Works, Chiba</td>
<td>About ¥11 billion</td>
</tr>
<tr>
<td></td>
<td>Nippon Steel, Kimitsu Works</td>
<td>About ¥33 billion</td>
</tr>
<tr>
<td>FY2019</td>
<td>Nippon Steel, Muroran Works</td>
<td>About ¥13 billion</td>
</tr>
<tr>
<td></td>
<td>JFE Steel, West Japan, Fukuyama Works</td>
<td>About ¥13.5 billion</td>
</tr>
</tbody>
</table>

**2. Planned Updating Projects (5 ovens)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Steel works</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY2021</td>
<td>JFE Steel, West Japan Works, Fukuyama</td>
<td>About ¥13 billion</td>
</tr>
<tr>
<td></td>
<td>Nippon Steel, Nagoya Works</td>
<td>About ¥57 billion</td>
</tr>
</tbody>
</table>

*Red projects: steel works affected by the Great East Japan Earthquake.*
(Reference) Unit heat consumption (index) in coke ovens

Heat consumption per ton of coke (The index is set at 100 for FY 2005.)

- All coke ovens in operation
- Three coke ovens in eastern Japan
- Coke ovens other than those affected by the Great East Japan Earthquake

- Updating Coke ovens in FY 2018 (total 3 ovens)
  - Nippon Steel, Kashima and Kimitsu Works
  - JFE Steel, East Japan Works, Chiba

- Updating Coke ovens in FY 2016 (total 3 ovens)
  - Nippon Steel, Kashima and Kimitsu Works
  - JFE Steel, East Japan Works, Chiba

Major Initiatives implemented or planned since FY2005

<table>
<thead>
<tr>
<th>1. Next generation coke ovens (Implementing SCOPE21)</th>
<th>2. More efficient power</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Implement period</strong></td>
<td>Kobe Steel Kakogawa Station No. 1 Gas turbine combined cycle unit (2011)</td>
</tr>
<tr>
<td><strong>Production capacity</strong></td>
<td>Kimitsu Joint Thermal Station No. 6 Advanced combined cycle unit (2012)</td>
</tr>
<tr>
<td>Nippon Steel, Oita Works</td>
<td>Kashima Joint Thermal Station No. 5 Advanced combined cycle unit (2013)</td>
</tr>
<tr>
<td>2008</td>
<td>Wakayama Joint Thermal Station No. 1 Advanced combined cycle unit (2014)</td>
</tr>
<tr>
<td>About 1 million tons /year</td>
<td>Oita Joint Thermal Station No. 3 Advanced combined cycle unit (2015)</td>
</tr>
<tr>
<td>Investment amount</td>
<td>Kobe Steel Kakogawa Station No. 2 Gas turbine combined cycle unit (2015)</td>
</tr>
<tr>
<td>About ¥ 37billion</td>
<td>JFE Steel Chiba Station West-No. 4 Gas turbine combined cycle unit (2015)</td>
</tr>
<tr>
<td><strong>Expected effects</strong></td>
<td>Nisshin Steel Kure Power Station No. 6 Boiler, turbine and generator (planned for 2017)</td>
</tr>
<tr>
<td>Compared to conventional coke ovens, CO2 equivalent: ▲0.4 million ton / year</td>
<td>JFE Steel Ohgishima Thermal Station No. 1 Gas turbine combined cycle (planned for 2019)</td>
</tr>
<tr>
<td>Compared to existing coke ovens, ▲0.1-0.2 million ton CO2 / year</td>
<td>Fukuyama Joint Thermal Station No. 2 Gas turbine combined cycle (planned for 2020)</td>
</tr>
</tbody>
</table>

Advanced Combined Cycle Power Generation

Source: Kimitsu Cooperative Thermal Power Company, Inc.
Introduction of AI, IoT, and other Digital Technologies

Steelmakers are increasingly introducing AI, IoT, and other advanced digital technologies. This is expected to contribute to preventing operational troubles and stabilizing operations (energy saving).

Examples of technologies introduced by JISF member companies
(excerpted from data released by JISF member companies)

Nippon Steel Corporation

• At the No.2 blast furnace of Muroran Works, Nippon Steel introduced a system to predict conditions inside a blast furnace by using a mathematical model. AI helps automatically adjust and achieve optimal operational conditions.

JFE Steel Corporation

• JFE Steel introduced a data science technology at its domestic blast furnaces for the purpose of developing a cyber-physical system (CPS). This enables to detect signs of abnormality and predict conditions inside a blast furnace to achieve stable operations.

Kobe Steel, Ltd.

• At the No.2 blast furnace of Kakogawa Works, Kobe Steel introduced a system to predict blast furnace heat levels by using AI. This enables to predict hot metal temperature automatically and highly accurately.
JISF’s commitment to a Low Carbon Society has the goal of raising the use of waste plastics and other recycled materials to 1 million tons, assuming the government establishes the necessary collection infrastructure. However, collections totaled 450,000 tons in FY2019, unchanged from FY2005 collections of recycled materials.

A great amount of CO₂ emission reduction is possible by reexamining associated policies for the use of waste plastics and other materials. At government councils and other opportunities, JISF constantly ask for reviews of the current recycling system and revisions as soon as possible.

Source: The Japan Iron and Steel Federation
As for the procurement of plastic packaging and containers, priority is given to material recycling, and therefore, the quantity of plastic packaging and containers bid for and purchased for chemical recycling (using blast furnaces or coke ovens) is showing little growth.

The bidding system was revised in FY 2018, enabling companies that fail to successfully bid for and purchase plastic packaging and containers designated specifically for material recycling can now bid for plastic packaging and containers designated for general purposes (chemical recycling, etc.). In FY 2019, the quantity of plastic packaging and containers bid for and purchased for chemical recycling increased slightly from FY 2018, but remained at a level similar to that in previous years.

Volume Purchased and Unit Price by Method for Recycling Container and Packaging Plastics

Source: The Japan Containers and Packaging Recycling Association
For expansion of chemical recycling

- Chemical recycling produces fewer residues than material recycling, and under chemical recycling, almost the whole of materials is recycled. In addition, unit contract prices are low (this means that the recycling-related social cost is low). Chemical recycling is an excellent recycling method.

- Currently, steelmakers can process about 300,000 tons of plastic packaging and containers by using their steel production processes.

- To efficiently promote recycling, it is necessary to promptly revise the existing structure from the following viewpoints.

1. From the standpoint of efficiently and effectively using waste materials (recycling waste materials that are highly effective at cutting CO2 emissions and have a low social cost), the container and packaging recycling system should stop placing priority on recycling materials that produce only small reductions in CO2 emissions.

2. Collection of waste materials should not be restricted to items covered by the Container and Packaging Recycling Law; collecting product plastic waste and other materials also could reduce the need for consumers to discard trash by category and reduce the trash classification expenses for local governments. The government should thus consider expanding recycling activities to include more types of materials. It is also necessary to consider establishing a pickup system, a quality guarantee system on a par with those stipulated in the Containers and Packaging Recycling Law.

Materials Received, Products Sold and Reuse Ratio by Method (FY2019)

<table>
<thead>
<tr>
<th>Fiscal year</th>
<th>Material</th>
<th>Chemical</th>
<th>Material/Chemical</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY2000</td>
<td>109,300</td>
<td>94,200</td>
<td>86.2</td>
</tr>
<tr>
<td>FY2005</td>
<td>109,300</td>
<td>73,000</td>
<td>66.8</td>
</tr>
<tr>
<td>FY2010</td>
<td>74,498</td>
<td>38,646</td>
<td>51.9</td>
</tr>
<tr>
<td>FY2011</td>
<td>71,583</td>
<td>37,631</td>
<td>52.6</td>
</tr>
<tr>
<td>FY2012</td>
<td>69,789</td>
<td>40,481</td>
<td>58.0</td>
</tr>
<tr>
<td>FY2013</td>
<td>66,401</td>
<td>41,561</td>
<td>62.6</td>
</tr>
<tr>
<td>FY2014</td>
<td>63,377</td>
<td>43,546</td>
<td>68.7</td>
</tr>
<tr>
<td>FY2015</td>
<td>59,561</td>
<td>44,991</td>
<td>75.5</td>
</tr>
<tr>
<td>FY2016</td>
<td>50,652</td>
<td>41,326</td>
<td>81.6</td>
</tr>
<tr>
<td>FY2017</td>
<td>54,897</td>
<td>45,210</td>
<td>82.4</td>
</tr>
<tr>
<td>FY2018</td>
<td>54,945</td>
<td>43,336</td>
<td>78.9</td>
</tr>
<tr>
<td>FY2019</td>
<td>56,406</td>
<td>40,078</td>
<td>71.1</td>
</tr>
<tr>
<td>FY2020</td>
<td>58,211</td>
<td>46,743</td>
<td>80.3</td>
</tr>
</tbody>
</table>
The Research Institute of Innovative Technology for the Earth (RITE) issued a report in 2018 on international comparison of energy efficiency level in steel industry (BF-BOF*). The report revealed that Japan maintains the world’s highest energy efficiency in 2015, as in 2005 and 2010.

1. Eco Process

Why is Japan’s steel industry the most efficient?

- The penetration rate of energy-saving technologies is very high in Japan’s steel industry.
- Steelmakers are working on achieving the goals of the JISF’s Commitment to Low Carbon Society and sharing best-practice knowledge among themselves.

In addition to actions in Japan, increasing the use of energy-saving measures and technologies worldwide will be an effective way to further lower CO₂ emissions in the steel industry.
To achieve the Phase I target, JISF are tracking the progress on a quarterly basis from the 2nd half of 2019.

Nationwide crude steel production in FY 2020 stands at about 80 million tons, far lower than that of FY 2019. Under extremely unusual circumstances where furnaces suspend blasting on a large scale, the current blast furnace operations seem to be showing discontinuity from those until FY 2019.

Until FY 2019, crude steel production was within the range between 93.72 million tons and 116.89 million tons (the range difference was about 20 million tons), and the BAU line and its pig iron ration adjustments were appropriate.

The current BAU line is a linear function developed from regression analysis based on the actual results between fiscal 2005 and FY 2009 (the production range: 96.45 million tons - 121.51 million tons for crude steel produced nationwide, and 93.72 million tons - 116.89 million tons for crude steel produced by the participating companies). (Linear function: \( y=1.271x+0.511 \))

For reference, if the current BAU line is extended to the latest production level, and this is evaluated in comparison with BAU emissions on the basis of the estimated amount for the period between April and September, the result is far higher than the reduction target compared to BAU emissions (3 million tons). There is discontinuity from previous years.
Evaluation of the Phase I Target (FY 2020 Target)

- As mentioned below, the circumstances of FY 2020 are showing discontinuity from those until FY 2019, reflecting the COVID-19 outbreak, and it is difficult to conduct appropriate evaluation based on the BAU line.

  1. Steel production in FY 2020 declined sharply due to the effects of the COVID-19 outbreak, and the current operations are showing discontinuity from those until FY 2019.

  2. The level of production deviates sharply from the production range assumed at the time of setting the current BAU line (between 93.72 million tons and 116.89 million tons for crude steel produced by the participating companies), and the current operational circumstances are different from those in the past. Therefore, the appropriateness of evaluation in comparison with BAU emissions cannot be secured.

  3. The production level in any of the 30 years from FY 1990 is not close to the FY 2020 level, and it is difficult to set a new BAU line within this production range.

- In view of these situations, the level of achievement of the Phase I target should be evaluated based on the actual results of FY 2019, which are the latest results that can be used to conduct appropriate evaluation on the basis of the current BAU line, instead of the actual results of FY 2020.

- It is difficult to use the actual results of FY 2020 for appropriate evaluation on the basis of the current BAU line, but the amount of actual emissions and the steel industry’s activities for FY 2020 will be reported as usual.

About the Phase II Target (FY 2030 Target)

- The current Phase II target (the 2030 CO₂ emissions reduction target compared to BAU emissions (a reduction of 9 million tons)) is also based on the same BAU line. But the production structure will be changed due to the suspension or closure of coke ovens, blast furnaces, and other facilities starting from 2021, and operational continuity will be lost. Consequently, it will be necessary to consider revising the Phase II target, in view of the possibility that it may become impossible to manage the target on the basis of the current BAU line.
### (Reference) List of Blast Furnaces Banked, Suspended due to COVID-19
(as of February 2021; prepared based on data released by steelmakers and news reports)

<table>
<thead>
<tr>
<th>Time of suspension</th>
<th>Time of resumption of operation</th>
<th>Steelworks name</th>
<th>Blast furnace name</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feb, 2020</td>
<td>-</td>
<td>Nippon Steel Setouchi Works, Kure Area</td>
<td>No. 2 blast furnace</td>
<td>The blast furnace will be officially closed by the end of the first half of FY 2021.</td>
</tr>
<tr>
<td>Apr, 2020</td>
<td>Jan, 2021</td>
<td>Nippon Steel East Nippon Works, Kashima Area</td>
<td>No. 1 blast furnace</td>
<td></td>
</tr>
<tr>
<td>Apr, 2020</td>
<td>-</td>
<td>Nippon Steel Kansai Works, Wakayama Area</td>
<td>No. 1 blast furnace</td>
<td>The blast furnace will be officially closed in the first half of FY 2022.</td>
</tr>
<tr>
<td>Apr, 2020</td>
<td>-</td>
<td>JFE Steel West Japan Works, Kurashiki</td>
<td>No. 4 blast furnace</td>
<td>The blast furnace was suspended because its renewal schedule was moved up.</td>
</tr>
<tr>
<td>June, 2020</td>
<td>Nov, 2020</td>
<td>Nippon Steel East Nippon Works, Kimitsu Area</td>
<td>No. 2 blast furnace</td>
<td></td>
</tr>
<tr>
<td>June, 2020</td>
<td>Sep, 2020</td>
<td>JFE Steel West Japan Works, Fukuyama</td>
<td>No. 4 blast furnace</td>
<td></td>
</tr>
<tr>
<td>July, 2020</td>
<td>Nov, 2020</td>
<td>Nippon Steel Muroran Works</td>
<td>No. 2 blast furnace</td>
<td>The blast furnace was suspended because its renewal schedule was moved up.</td>
</tr>
<tr>
<td>July, 2020</td>
<td>-</td>
<td>Nippon Steel Kyushu works, Yawata Area</td>
<td>Kokura No. 2 blast furnace</td>
<td>The blast furnace was closed ahead of the original schedule.</td>
</tr>
</tbody>
</table>
(Reference) List of Blast Furnaces and Coke Ovens to be Closed
(as of February 2021; prepared based on data released by steelmakers)

<table>
<thead>
<tr>
<th>Scheduled time of closure</th>
<th>Steelworks name</th>
<th>Blast furnaces and coke ovens to be closed</th>
</tr>
</thead>
<tbody>
<tr>
<td>By the end of the first half of FY 2021</td>
<td>Nippon Steel Setouchi Works, Kure Area</td>
<td>Blast furnaces 2 → 0 (Closure of No. 1 and No. 2 furnaces)</td>
</tr>
<tr>
<td>In the first half of FY 2022</td>
<td>Nippon Steel Kansai Works, Wakayama Area</td>
<td>Blast furnaces 2 → 1 (Closure of No. 1 furnace) Coke ovens 3 → 1 (Closure of No. 4 and No. 5 ovens)</td>
</tr>
<tr>
<td>In FY 2023</td>
<td>JFE Steel East Japan Works, Keihin</td>
<td>Blast furnaces 1 → 0 (Closure of No. 2 furnace) Coke ovens 2 → 0 (Closure of No. 1 and No. 2 ovens)</td>
</tr>
</tbody>
</table>
2. Eco Solution
Eco Solution: CO₂ Emission Reduction from Increasing Use of Technologies

- There is much potential for increasing the use of major energy conservation technologies globally, especially in India where steel production is expected to continue to grow.
- Major energy conservation technologies developed and used in the Japanese steel industry are already lowering CO₂ emissions overseas as Japanese companies provide these technologies to other countries. CDQ, TRT and other major types of equipment alone are already lowering annual aggregate CO₂ emissions in China, Korea, India, Russia, Ukraine, Brazil and other countries by 68.57 million tons.

Results of potential evaluation for the recovery and efficient use of by-product gases (2015)

Emission Reductions in Other Countries from Japanese Energy-conserving Equipment (FY2019)

<table>
<thead>
<tr>
<th>Technology</th>
<th>No. of units</th>
<th>Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coke dry quenching (CDQ)</td>
<td>114</td>
<td>22.96</td>
</tr>
<tr>
<td>Top-pressure recovery turbines (TRT)</td>
<td>65</td>
<td>11.50</td>
</tr>
<tr>
<td>Byproduct gas combustion (GTCC)</td>
<td>56</td>
<td>24.02</td>
</tr>
<tr>
<td>Basic oxygen furnace OG gas recovery</td>
<td>22</td>
<td>8.21</td>
</tr>
<tr>
<td>Basic oxygen furnace sensible heat recovery</td>
<td>8</td>
<td>0.90</td>
</tr>
<tr>
<td>Sintering exhaust heat recovery</td>
<td>7</td>
<td>0.98</td>
</tr>
<tr>
<td><strong>Total emission reduction</strong></td>
<td><strong>68.57 Mt</strong></td>
<td></td>
</tr>
</tbody>
</table>

Ref: Total emission reduction in FY2017 was 65.53 Mt - CO₂/year

Energy conservation potential through the spread of major energy conservation technologies

*CDQ: Coke Dry Quenching  
TRT: Top Pressure Recovery Turbines  
GTCC: Gas Turbine Combined Cycle system*
Japan-China Steel Industry Environmental Protection and Energy Conservation Technology Conference (2005~)

The Public and private collaborative meeting between Indian and Japanese Iron and Steel Industry (2011~)

ASEAN-Japan Steel Initiative (2014~)

APP Steel TF (2006~2010)
APP: Asia Pacific Partnership

GSEP Steel WG(2010~2015)
GSEP: Global Superior Energy Performance Partnership

ENCO (~2009)
Environment Committee

EPCO (2010~2013)
Environmental Policy Committee

ECO (2014~)
Environment Committee

“CO₂ Breakthrough Program”: Participating with COURSE50 (2003~)

CO₂ data collection (2007~)

Development of ISO14404* (2009~)
Versions for integrated steel plants and EAF issued in 2013, version for DRI-EAF in 2017 and version for all types of process in 2020

*International standard for the calculation of CO₂ emission from steel plants

Bilateral Activities

Multilateral Activities

worldsteel etc.
2020 AJSI Webinar
Energy-Efficient and Environmental Transition towards Sustainable Steel Industry

Outline

Schedule: December 14, 2020 (3 hours)
Location: Online
Participants from seven ASEAN countries*: Ministries and agencies related to steel and energy conservation and steel industry organizations and their member companies**
Participants from Japan: Ministry of Economy, Trade and Industry, JISF and its member companies, etc. (over 200 people)*: Myanmar, Thailand, Malaysia, the Philippines, Vietnam, Indonesia, Singapore

Seminar details

- Japanese participants presented energy saving technologies and case study of energy saving, and Thai participants presented examples relating to Japan’s past support.
- In the ASEAN region, steel is produced mainly at electric furnaces, and many companies do not have or have suspended electric furnaces and hot strip production facilities. Therefore, the seminar also actively dealt with examples small-scale technologies and operational improvement with low-cost.

Viewpoint Examples and technologies

| Short-term improvement | - Case study of cost and energy saving by Japanese electric furnace makers |
| - Representative technologies relating to electric furnace energy conservation and examples of operational improvement |
| - Presentation of energy conservation technologies for electric furnaces by technology suppliers |

| Medium- to long-term improvement | - Outline of the Joint Crediting Mechanism (JCM) |
| - ISO14404, which specifies calculation methods for CO₂ emissions at steelworks |
| - Examples of CO₂ emission benchmarking activities in Thailand |
| - Latest policies and technology trends for achievement of sustainable growth of the steel industry |

Evaluation by participants

- There were high marks for the presentation of examples of efforts for operational improvement that can be implemented even during the COVID-19 pandemic and low-cost technologies for energy conservation.
- Also regarding technological and policy-related initiatives for achievement of low-carbon or zero-carbon production in the steel industry on a long-term basis, there are high expectations for the provision of information and cooperation by the Japanese steel industry.

Evaluation by the SEAISI

- On its website, the SEAISI* reported the outline of the webinar and expressed its gratitude to Japanese participants and others.

*Excerpted from surveys conducted after the seminar. **: Persons in charge at energy conservation-related divisions, engineering divisions, marketing divisions, accounting divisions, etc. participate in the seminar.
3. Eco Product
Japanese manufacturers have taken the lead in developing and commercializing many highly efficient industrial products. Examples include fuel-efficient automobiles and highly efficient power generation equipment and transformers. These products have made a big contribution to conserving energy and cutting CO₂ emissions in Japan and worldwide.

The Japanese steel industry has established a close relationship with these manufacturers by developing and supplying steel that has a variety of characteristics. This high-performance steel is vital to achieving the outstanding functions of advanced products and has earned a reputation for reliability among manufacturers.

### Eco Product: Japanese Industrial Products that Conserve Energy and Cut CO₂ Emissions

- **Generator parts**
  Steel for high-efficiency power plant turbines can withstand high temperatures and high rotation speeds

- **Boiler tubes**
  Steel tubes that resist high temperatures and corrosion make power generation more efficient

- **Airplane components**
  Strong and durable jet engine shafts further boost maximum thrust = Longer range, better fuel efficiency

- **Automotive and industrial machinery parts**
  Strong gear steel increases gears and reduces size and weight – higher fuel efficiency

- **Motors for hybrid/electric cars**
  High-efficiency non-oriented electrical sheets for higher fuel efficiency, more power, smaller size and lower weight

- **Suspension springs**
  Higher strength steel for valve and suspension springs used in punishing applications makes vehicles lighter and lowers fuel consumption
To establish a method to determine the quantitative contribution of high-performance steel, JISF established in FY2001 a committee with the participation of associations of steel-consuming industries, The Institute of Energy Economics, Japan and the Japanese government. The committee has been monitoring contributions every year since then.

Statistics are for the five major types of high-performance steel for which quantitative data are available (FY2019 production of 7.06 million tons, 7.2% of Japan’s total crude steel output). The use of finished products made of high-performance steel cut FY2019 CO₂ emissions by 10.13 million tons for steel used in Japan and 21.81 million tons for exported steel, a total of 31.94 million tons of CO₂.

CO₂ Emission Reductions by the five major types of high-performance steel (FY2019)

1. Domestic

- Transformers
- Trains
- Automobiles
- Power generation boilers
- Ships

CO₂ reduction 10.13 Mt-CO₂

2. Export

- Transformers
- Trains
- Automobiles
- Power generation boilers
- Ships

CO₂ reduction 21.81 Mt-CO₂

CO₂ Emission Reductions: 31.94 million tons CO₂ in total (7.06 million tons of high-performance steel)

Source: The Institute of Energy Economics, Japan

*The five categories are automotive sheets, oriented electrical sheets, heavy plates for shipbuilding, boiler tubes and stainless steel sheets. In FY2019, use of the five categories of steel products in Japan was 3.62 million tons and exports were 3.44 million tons for a total of 7.06 million tons.

*Assessments in Japan started in FY1990 and for exports assessments started in FY2003 for automobiles and shipbuilding, in FY1998 for boiler tubes, and in FY1996 for electrical sheets.
Steel products have greatly improved their mechanical and electromagnetic properties. However, the characteristic level we put into practical use is only 1/10-1/3 (in the case of strength) with respect to the theoretical limit value.

The Japanese steel industry will contribute to the reduction of CO2 in the entire life cycle, while supporting the foundation of the future society, through not only further strengthening steel products but also developing next-generation steel products for hydrogen infrastructure to be expected in the future.
4. Promotion of CO$_2$ Ultimate Reduction System for Cool Earth 50 Development (COURSE50)
Development of CO₂ Ultimate Reduction System for Cool Earth 50 (COURSE50)

Project summary
Work is underway on developing technology for using hydrogen for the reduction of iron ore (method for lowering blast furnace CO₂ emissions). Hydrogen in the very hot coke oven gas (COG) generated during coke production is amplified and then used to replace some of the coke. Furthermore, for the separation of CO₂ from blast furnace gas (BFG), a revolutionary CO₂ separation and collection technology (technology for separating and collecting CO₂ from blast furnaces) will be developed that utilizes unused heat at steel mills. The goal is to use these technologies for low-carbon steelmaking that cuts CO₂ emissions by about 30%. (NEDO-commissioned project)

Development schedule

<table>
<thead>
<tr>
<th>Year</th>
<th>Basic technology development Phase 1, Step 1 (2008~12)</th>
<th>Comprehensive technology development Phase 1, Step 2 (2013~17)</th>
<th>Development of practical use Phase 1</th>
<th>Actual use and increase in use</th>
<th>All blast furnaces are to be switched to this technology by 2050 as blast furnace facilities are updated and replaced.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* assumptions are that an international equal footing is established and the necessary social infrastructure is created, including the site selection and establishment of a storage facility for government-led carbon capture and sequestration programs. Targets will be reexamined if these conditions are not fulfilled.</td>
</tr>
</tbody>
</table>
5. Reference
ISO50001 is an international standard for energy management systems that was issued in June 2011.

On February 20, 2014, JISF became the first industrial association in the world to receive ISO50001 certification, the result of global warming and energy conservation measures associated with the voluntary action plan and the Commitment to a Low Carbon Society.

This certification is proof that the voluntary actions of the steel industry are sufficiently transparent, reliable and effective in relation to the requirements of international standards.

**JISF Energy Management System**

- **Plan**: JISF establishes the highest possible goals based on available technologies.
  - Suitability of the plan is confirmed by providing explanations during the target setting process to the government advisory council and the Keidanren third-party evaluation committee.

- **Do**: Member companies take actions for conserving energy and cutting CO2 emissions based on JISF targets.
  - JISF checks the progress by reporting to each companies president at its Executive Board Meeting.

- **Action**: The plan is revised as needed based on assessments and instructions from the government advisory council (steel working group) and Keidanren third-party evaluation committee.

- **Check**: Performance is evaluated every year by the government advisory council (steel working group) and Keidanren third-party evaluation committee.
Investments for Environmental Protection and Energy Conservation

- The Japanese steel industry made investments of about ¥3 trillion between FY1971 and FY1989 for environmental protection and energy conservation. These investments totaled about ¥1.8 trillion between FY1990 and FY2012.
- Investments for rationalization and labor-saving totaled about ¥2.0 trillion between FY2005 and FY2019.

Fig. Accumulative investment for environmental facilities since FY1971

Fig. Accumulative investment for rationalization and labor-saving since FY1999


Source: Development Bank of Japan Inc
# Energy Conservation Initiatives of the Steel Industry

<table>
<thead>
<tr>
<th>Period</th>
<th>Initiatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>'70s</td>
<td>1) Process innovations (Continuous casting, continuous annealing, etc.)</td>
</tr>
<tr>
<td></td>
<td>Process improvements (Hot charge rolling, automated combustion control, etc.)</td>
</tr>
<tr>
<td>'80s</td>
<td>2) Recovery and efficient use of byproduct gases (Gas holder, high-efficiency gas turbine combined cycle generation, etc.)</td>
</tr>
<tr>
<td></td>
<td>3) Exhaust heat recovery (TRT, (CDQ), etc.)</td>
</tr>
<tr>
<td>'90s</td>
<td>4) Use of waste materials (Waste plastics and tires, biomass)</td>
</tr>
<tr>
<td>'00s</td>
<td>SCOPE-21 (Constant improvements)</td>
</tr>
<tr>
<td></td>
<td>Artificial intelligence, supply chain network, etc.</td>
</tr>
<tr>
<td>'10s</td>
<td>Constant improvements (Hydrogen amplification, CO₂ recovery)</td>
</tr>
<tr>
<td></td>
<td>Recovery of mid/low-temp. exhaust heat</td>
</tr>
</tbody>
</table>

**Diagram:**

- **Total energy consumption**
  - Net consumption
  - Recovered

- **Periods:** '73, '80, '90, '00, '10

- **Initiatives:**
  - Process innovations
  - Process improvements
  - Byproduct gas use
  - Exhaust heat recovery
  - Waste material use

- **Notes:**
  - 5. Reference – Eco Process
According to the IEA, Japan has the world’s smallest potential for energy conservation per ton of crude steel. According to RITE, Japan has the world’s most energy efficient steel industry. These figures demonstrate that virtually all steel mills in Japan use existing technologies and that there is very little potential for further energy-conservation measures.

International Comparison of Energy Efficiency in the Steel Industry

| Source: IEA “Energy Technology Perspective 2014” |


| Source: RITE “Estimated Energy Unit Consumption in 2015” |

**2.29 Energy savings potential in 2011**

Japan has the world’s highest energy efficiency.

**Estimate of Steel Industry (BF-BOF) Energy Efficiency**

(2015, Japan=100)

Japan’s energy conservation potential per ton of crude steel is the smallest in the world.
Crude Steel Output and Total and Unit CO₂ Emissions

Crude Steel Output and CO₂ Emissions
(constant FY2005 electric power emission coefficient)

Crude Steel Output and Unit CO₂ Emissions
(constant FY2005 electric power emission coefficient)
As of the end of 2015, the per capita steel stock in Japan was 10.7 tons compared with 4.0 tons worldwide.

Steel stock per capita is an indicator of the penetration of social infrastructure and industrial products, which are a measure of prosperity. The steel stock is expected to grow steadily in emerging countries as these countries become more prosperous and accomplish Sustainable Development Goals (SDGs).

Global crude steel output will increase for many more years

India’s steel industry plans to approximately triple crude steel output to 300 million tons by 2030.

Source: worldsteel
The Japanese Steel Industry’s Overseas Contributions to Energy Conservation

   • This conference has been held periodically since steel industry leaders of the two countries signed an MoU in July 2005. Providing a forum for exchanges of information about steel technologies, this conference plays a key role in international steel industry cooperation.
   • The 11th conference was held in Taiyuan, China's Shanxi Province, in October 2019. It has been over 10 years since the first conference was held. It has been confirmed that Chinese mills have advanced greatly in terms of environmental protection and energy conservation measures, and this event has helped Chinese mills undertake relevant measures (In 2020, this Conference was postponed due to the COVID-19.)

2. India: Public and Private Collaborative Meeting between the Indian and Japanese Steel industries (2011~)
   • Started in 2011, this meeting has been held eight times, bringing together public and private-sector energy conservation experts in the two countries.
   • The Japanese steel industry has provided assistance concerning the introduction of its energy conservation technologies in India. Activities include steel plant diagnosis using ISO14404, the establishment of a Technologies Customized List containing energy conservation technologies suitable for India, and technology seminars held by Japanese manufacturers of energy conservation equipment.

3. ASEAN: ASEAN-Japan Steel Initiative (2014~)
   • Started in February 2014, this initiative brings together steel industry energy conservation professionals from Japan and six ASEAN countries. Since the start of this initiative, workshops for specific themes have been held for the ASEAN region and individual countries to support energy conservation measures in the ASEAN steel industry.
   • There have been steel plant diagnoses at 14 ASEAN steel mills in order to provide advice for improving operations and using new technologies.
The Technologies Customized List contains information about technologies involving energy conservation and protecting the environment that are recommended for specific countries and regions. These lists have been prepared for India and the ASEAN region.

The Technologies Customized List for India

35 recommended technologies
(33 techs for Bf-BOF and 34 techs for EAF)

Energy conservation benefits, technology suppliers and other information

Technology Explanation Sheets
Thorough explanations of individual technologies

At nine steelworks where steel plant diagnoses were implemented between 2007 and 2018, Japanese experts recommended the introduction of energy conservation technologies in 42 cases on the basis of the Technologies Customized List. About 70% of the recommended technologies have been introduced or are planned to be introduced (as of January 2021).

Technologies recommended for steelworks where energy conservation diagnoses have been implemented and technologies that have been introduced

<table>
<thead>
<tr>
<th>Number of technologies recommended</th>
<th>42</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of technologies introduced*</td>
<td>15 (36%)</td>
</tr>
<tr>
<td>Number of technologies planned to be introduced</td>
<td>14 (33%)</td>
</tr>
</tbody>
</table>

*Many of them are large-scale, cost-effective technologies, including coke dry quenching (CDQ) and top-pressure recovery turbines (TRT).
Steel Plant Diagnosis

Objective

1. Evaluate energy efficiency level of the steel plant using ISO14404*.
2. Recommend energy saving technologies from Technologies Customized List (TCL) based on the equipment diagnosis to encourage technology transfer from Japan

*ISO14404 is an international standard for calculating CO2 emissions from a steel plant.

The steel plant diagnoses have been performed at 26 locations.
✓ 12 plants in India
✓ 14 plants in the ASEAN region in 6 countries*

*Indonesia, Singapore, Thailand, Philippines, Vietnam, Malaysia

Day1~3

1. Operation observation of BF-BOF, EAF, reheating furnace and other facilities

2. Energy data collection by using ISO14404

Day4

3. Reporting session

Based on ISO14404, Japanese experts
1. analyze energy consumption trend
2. recommend suitable energy saving technologies mainly from TCL
3. provide advice for operational improvement
The Importance of Increasing the Use of Eco Product

- High-performance steel generally has higher CO$_2$ emissions than ordinary steel does during the manufacturing stage. But high-performance steel is an eco product because it greatly lowers CO$_2$ emissions when used by making finished products more energy efficient.
- By supplying high-performance steel, the Japanese steel industry is making a big contribution to energy conservation and cutting CO$_2$ emissions in Japan and around the world. Furthermore, this steel supports “green” economic growth in Japan and creates jobs as the steel is exported to users worldwide.
- Global demand for electricity and motor vehicles is certain to increase as economic growth continues, chiefly in emerging countries. Demand for high-performance steel is expected to become even greater as a result. Meeting the need for high-performance steel will therefore be critical from the standpoints of supporting Japan’s economic growth and protecting the global environment.

Source: The Institute of Energy Economics, Japan

### Asia/Global Energy Outlook 2015 by The Institute of Energy Economics, Japan

<table>
<thead>
<tr>
<th>Global Automobile units in operation</th>
<th>Global Electricity Output</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>World outside Asia</strong></td>
<td><strong>Asia</strong></td>
</tr>
<tr>
<td>Year</td>
<td>Million vehicles</td>
</tr>
<tr>
<td>1990</td>
<td>577</td>
</tr>
<tr>
<td>2000</td>
<td>767</td>
</tr>
<tr>
<td>2013</td>
<td>1,195</td>
</tr>
<tr>
<td>2020</td>
<td>1,449</td>
</tr>
<tr>
<td>2030</td>
<td></td>
</tr>
</tbody>
</table>

Source: The Institute of Energy Economics, Japan
Eco Product Contribution: Quantitative Evaluation of Contribution of High Strength Sheets for Automobiles

Summary

Emissions can be effectively reduced at the in-use stage by using high-function steels in components of final products. High strength steel sheets for automobiles are steel sheets that can be thinned out while maintaining high strength (and thus reducing steel product weight). Automobiles using this material are lighter than those using conventional steel sheets without such features, thus leading to fuel efficiency improvements that enable CO₂ emission reductions during operation.

Quantification results of avoided emissions

Avoided emissions at the in-use stage of high strength steel sheets for automobiles in FY 2017 were as provided below:

- Domestic use: 4.5 million t-CO₂
- Exports: 8.49 million t-CO₂
- Total: 12.99 million t-CO₂

Avoided emissions were calculated using the formula provided below. A cross-sectional assessment was conducted for total stock in a given year to estimate avoided emissions.

Avoided emissions = Number of new cars manufactured × Average travel distance × Fuel efficiency improvement rate / Average fuel efficiency of new cars × Average years in use

Assumptions

1. Baseline scenario
   The case study assessed CO₂ emission reductions from improving fuel efficiency at the in-use stage of automobiles by replacing steel sheets without special functions (normal steel), which serve as the baseline, with high strength steel sheets up to the current share.

<table>
<thead>
<tr>
<th>Source</th>
<th>Assessed steel sheets</th>
<th>Energy savings due to reducing steel sheet weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automobiles</td>
<td>Normal steel</td>
<td>High strength steel sheets (YPS45)</td>
</tr>
</tbody>
</table>

2. Assumptions
   High strength steel sheets can be made thinner than baseline normal steel while maintaining high strength; and therefore, automobiles using this material are lighter than those using conventional steel sheets without such properties, thus leading to fuel efficiency improvements that enable CO₂ emission reductions during operation. (Quantifications are estimates based on actual data.)

(2) Scope of quantification

1. Target steel sheets
   Steel sheets used domestically and exported steel. (Steel exports from 2009)
   The case study covered only steel manufactured in Japan, and excluded overseas manufacture. (Japanese steel manufacturers do not possess integrated steelworks overseas.)

2. Target stages
   The case study assessed CO₂ emission reductions due to fuel efficiency improvements at the in-use stage of automobiles.
   As raw material mining and transport account for a minuscule percentage of the entire life cycle of iron and steel, and also because the assessment involves replacing steel products, little change is seen at the manufacturing stage.
   When assessing the effect of reducing the weight of steel, CO₂ emissions from raw material mining and transport become less than the baseline in accordance with the reduced amount of steel used, but the Federation includes only the in-use stage in its quantifications.

(3) Assessment period

From the viewpoint of comparing CO₂ emissions from a manufacturing process during one fiscal year, the case study performed a cross-sectional assessment of stock.

(4) References

Papers on the method of analysis have been published on the Institute of Energy Economics, Japan website:

Research on Contribution of Steel Products to Society-wide Energy Conservation from LCA Perspectives (English) https://enken.ieej.or.jp/data/pdf/157.pdf
Research on Contribution of Steel Products to Society-wide Energy Conservation from LCA Perspectives (English) https://enken.ieej.or.jp/data/pdf/172.pdf

Source: Japan Business Federation, “Contributing to Avoided Emissions through the Global Value Chain”
Eco Product Contribution: Quantitative Evaluation of Contribution of High Tensile Strength Plates for Vessels

Summary

Emissions can be effectively reduced at the in-use stage by using high-function steels in components of final products. High tensile plates for vessels are steel plates that can be thinned out while maintaining high strength (and thus reducing steel product weight). Vessels using this material are lighter than those using conventional steel sheets without such features, thus leading to fuel efficiency improvements that enable CO₂ emission reductions during operation.

Quantification results of avoided emissions

Avoided emissions at the in-use stage of high tensile plates for vessels in FY2017 were as provided below:
- Domestic use: 1.94 million t-CO₂
- Exports: 0.61 million t-CO₂
- Total: 2.55 million t-CO₂

Avoided emissions were calculated using the formula provided below. A cross-sectional assessment was conducted for total stock in a given year to estimate avoided emissions.

Avoided emissions = Fuel consumed by vessels / (1 - Weight reduction rate of operating vessels x Contribution ratio to fuel savings) x (Weight reduction rate of operating vessels x Rate of contribution to fuel savings) x Calorific value of fuels

Source: Japan Business Federation, “Contributing to Avoided Emissions through the Global Value Chain”

Summary

Emissions can be effectively reduced at the in-use stage by using high-function steels in components of final products. Heat-resistant high strength steel tubes for generating boilers can resist higher temperatures than conventional heat-resistant steel tubes, and can thus improve the power generation efficiency of steam power plants. This leads to CO₂ emission reductions from fuel consumption savings.

Quantification results of avoided emissions

Avoided emissions at the in-use stage of heat-resistant tubes for generating boilers in FY2017 were as provided below:

- Domestic use: 0.96 million t-CO₂
- Exports: 4.30 million t-CO₂
- Total: 5.26 million t-CO₂

Avoided emissions were calculated using the formula provided below. A cross-sectional assessment was conducted for total stock in a given year to estimate avoided emissions. Avoided emissions = Fuel savings due to efficiency improvements achieved at 593°C – 600°C-class steam power plants as a result of shifting from 566°C-class steam power plants × Rate of contribution of high-performance heat-resistant tubes, or 25% × Number of years power plants are in service.

5. Reference – Eco Product

Source: Japan Business Federation, “Contributing to Avoided Emissions through the Global Value Chain”
Eco Product Contribution: Quantitative Evaluation of Contribution of Grain-oriented Sheets for Transformers

Summary

Emissions can be effectively reduced at the in-use stage by using high-function steels in components of final products. Current grain-oriented silicon steel sheets for transformers can reduce iron loss (energy loss) during transformation; and therefore contribute to efficient electric power transmission, and thus CO₂ emission.

Quantification results of avoided emissions

Avoided emissions at the in-use stage of grain-oriented silicon steel sheets for transformers in FY2017 were as provided below:

- Domestic use: 2.15 million t CO₂
- Exports: 6.51 million t CO₂
- Total: 8.66 million t CO₂

Avoided emissions were calculated using the formula provided below. A cross-sectional assessment was conducted for total stock in a given year to estimate avoided emissions.

Avoided emissions = minimum value × (Transformer no-load losses per unit capacity in an assessment year - Transformer no-load losses per capacity 30 years ago) × Hours of use

5. Reference – Eco Product

Source: Japan Business Federation, “Contributing to Avoided Emissions through the Global Value Chain”
Eco Product Contribution: Quantitative Evaluation of Contribution of Stainless Steel Sheets for Railway Cars

Summary

Emissions can be effectively reduced at the in-use stage by using high-function steels in components of final products. Stainless steel sheets from railway cars are steel plates that can be thinned out while maintaining high strength (and thus reducing steel product weight). Railway cars using this material are lighter than those using conventional steel sheets without such features, thus leading to fuel efficiency improvements that enable CO₂ emission reductions during operation.

Assessment of reductions at product in-use stage

Quantification results of avoided emissions

Avoided emissions at the in-use stage of stainless steel sheets for railway cars in FY2017 were as provided below:

- Domestic use: 0.27 million t-CO₂
- Exports: 0.1 million t-CO₂
- Total: 0.27 million t-CO₂

Avoided emissions were calculated using the formula provided below. A cross-sectional assessment was conducted for total stock in a given year to estimate avoided emissions.

Avoided emissions = Energy saved during operation per unit railway car weight reduced per unit distance travelled per car x Weight reduced per car x Annual distance travelled per car x Number of stainless steel railway cars produced annually

(1) Baseline scenario and assumptions

1. Baseline scenario

The case study assessed CO₂ emission reductions from improving fuel efficiency at the in-use stage of railway cars by replacing steel sheets without special functions (normal steel), which serve as the baseline, with stainless steel sheets up to the current share.

<table>
<thead>
<tr>
<th>Railway cars</th>
<th>Baseline</th>
<th>Assessed steel sheets</th>
<th>Energy savings due to reducing steel sheet weight</th>
</tr>
</thead>
</table>

2. Assumptions

High strength sheets can be made thinner than baseline normal steel while maintaining high strength, and therefore, railway cars using this material are lighter than those using conventional steel sheets without such properties, thus leading to fuel efficiency improvements that enable CO₂ emission reductions during operation. (Quantifications are estimates based on actual data.)

(2) Scope of quantification

1. Target steel sheets

Steel sheets used domestically and exported steel. (Steel exports from 2009)

The case study covered only steel manufactured in Japan, and excluded overseas manufacture. (Japanese steel manufacturers do not possess integrated steelworks overseas.)

2. Target stages

The case study assessed CO₂ emission reductions due to fuel efficiency improvements at the in-use stage of railway cars. As raw material mining and transport account for a minuscule percentage of the entire life cycle of iron and steel, and also because the assessment involves replacing steel products, little change is seen at the manufacturing stage. When assessing the effect of reducing the weight of steel, CO₂ emissions from raw material mining and transport become less than the baseline in accordance with the reduced amount of steel used, but the Federation includes only the in-use stage in its quantifications.

(3) Assessment period

From the viewpoint of comparing CO₂ emissions from a manufacturing process during one fiscal year, the case study performed a cross-sectional assessment of stock.

(4) References

Papers on the method of analysis have been published on the Institute of Energy Economics, Japan website:

- Research on Contribution of Steel Products to Society-wide Energy Conservation from LCA Perspectives (1) (English) https://www.jiec.or.jp/journals/pdf/165.pdf
- Research on Contribution of Steel Products to Society-wide Energy Conservation from LCA Perspectives (2) (English) https://www.jiec.or.jp/journals/pdf/172.pdf

Source: Japan Business Federation, “Contributing to Avoided Emissions through the Global Value Chain”
Eco Product: The global competitive edge of the Japanese steel industry, mainly for high-performance steel

- Steel from other countries is incomparable with Japan’s high-performance steel in terms of performance, quality, supply and other attributes. High-performance steel is the core element of the international competitive edge of the Japanese steel industry.

- China, the world’s largest steel producer, became a net exporter of steel in 2006. Japan is the only net exporter of steel to China now.

Steel Trade of China (Total) (10,000 tons)

- With Japan
  - Excess import
  - Excess export from 2005

- With Korea
  - Excess import
  - Excess export from 2005

- Total
  - Excess import
  - Excess export from 2006

Source: China’s customs statistics
CO₂ Emission Reduction from Blast Furnace Slag Used in Cement

Mixed cement (mainly slag cement) is one way to lower CO₂ emissions related to energy consumption. The use of this cement is growing and a further increase in the production ratio of mixed cement could significantly lower CO₂ emissions.

Replacing conventional cement (Portland cement), which generates CO₂ during the firing of raw materials, with slag cement, which does not generate CO₂ during production, reduced annual CO₂ emissions by 10.65 million tons/year (FY19).

- Japan: Annual reduction of 3.47 mn tons of CO₂
- Exports: Annual reduction of 7.18 mn tons of CO₂

Assumptions for emission reduction contribution:
Conversion to volume of cement: 450kg of slag/Ton of cement
CO₂ emission reduction: 312kg of CO₂/Ton of cement

Estimate of contribution of slag cement to reductions in CO₂ emissions (domestic plus export)

Source: Japan Cement Association, Nippon Slag Association
Initiatives in the cargo transport sector

- CO₂ emissions per unit of cargo transport decreased to 42.0kg of CO₂/k ton-km in FY19 from 44.0kg of CO₂/k ton-km in FY06.
- In FY19, the steel industry modal shift (ships + rail) was 76% for primary transportation and 96% for cargo transported more than 500km. This is far higher than the average modal shift rate of 38.1% for all industries in Japan (Ministry of Land, Infrastructure and Transport FY05 data for more than 500km).
- Steelmakers are taking other actions too, such as improving cargo transport efficiency by using a higher pct. of cargo space on ships, utilizing shore-based electric power supplies for ships and using eco-tires on trucks and using eco-friendly driving methods.

Use of binary power generation systems for ships

[Effects and characteristics]
- Using the exhaust heat from the main engines of ships, which was previously disused, as a heat source for power generation
- The power generated is used effectively as a supplemental power source for the ship. This contributes to reducing fuel used for generator engines and CO₂ emissions.

[Example of use of a binary power generation system]
Kobe Steel and Kawasaki Kisen Kaisha have jointly installed a binary power generation system on a coal ship, and the ship has been in operation since February 2019.

Fuel saving by using electricity from shore-based sources

Cuts fuel oil use by 70% to 90% while ships are docked

<table>
<thead>
<tr>
<th>No. of units</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel mills</td>
<td>218</td>
</tr>
<tr>
<td>Junction port</td>
<td>41</td>
</tr>
</tbody>
</table>

(Totals for 4 blast furnace and 2 EAF steelmakers as of the end of FY18)
Initiatives in commercial/residential sector

- In FY2005, Japan’s steelmakers started energy conservation programs using environmental ledgers for residential sector. Steelmakers started education programs that included all employees, including at group companies, promotion of use of household environmental ledgers, and other actions. There are around 17,000 households participating in this program in FY2019.

- The Japanese Steel industry is taking actions to reduce energy consumption and CO$_2$ emission from offices. Unit energy consumption in offices in 2019 was down 30% compared to FY 2008-2012.

**Household CO$_2$ Emissions**
(CO$_2$ emissions per individual: kg of CO$_2$/person-year)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>1454</td>
<td>797</td>
<td>762</td>
</tr>
<tr>
<td>Gasoline</td>
<td>467</td>
<td>799</td>
<td>753</td>
</tr>
</tbody>
</table>

**Unit energy consumption in offices**

- Unit energy consumption per floor area [MJ/m$^3$]

<table>
<thead>
<tr>
<th></th>
<th>Avg. FY08-FY12</th>
<th>FY19</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>1372</td>
<td>958</td>
</tr>
<tr>
<td>Gasoline</td>
<td>797</td>
<td>753</td>
</tr>
</tbody>
</table>

**Notes:**
1. Total for Japanese households includes households and household use of automobiles.
2. Total for steel industry households is an estimate by JISF based on the inventory in Japan

Data for 324 business sites of 67 companies in FY2019
Example of use of unused energy in nearby locations
Supply of heat to sake companies by a steelmaker in the Kobe area

Features of the heat source system
1. Supply of heat source
   Steam from a power plant is used as the heat source.
2. Energy conservation
   Energy use is down 30% from when each company had its own boiler. Part of steam used for power generation is drawn off from between turbines and supplied in order to reduce energy lost to cooling water.

Equipment

<table>
<thead>
<tr>
<th>Steam generators</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam generation:</td>
<td>40 tons/hour</td>
</tr>
<tr>
<td>Heating capacity:</td>
<td>29.5GJ</td>
</tr>
<tr>
<td>Thermal transmission area:</td>
<td>382m²</td>
</tr>
<tr>
<td>Primary steam pressure:</td>
<td>1.01MPa (saturation temperature)</td>
</tr>
<tr>
<td>Secondary steam pressure:</td>
<td>0.837MPa (saturation temperature)</td>
</tr>
</tbody>
</table>

Water softener: 1 set

Water supply method: Two-pipe system with direct-buried steam (300-150A) and recirculated water (50A) (24-hour supply all year)
(IPP) Examples of Efforts for Mixed-Firing Power Generation Using Forestry Residue

Characteristics
- Reducing greenhouse gas emissions by increasing the use of woody biomass
- Increasing the use of renewable energy that can generate power stably (biomass) under the feed-in tariff system
- Contributing to promoting the local forest industry and revitalizing the rural economy

Kamaishi Steelworks
Power generation facilities: Pulverized coal thermal power generation (149MW)
Quantity used: About 7,000 tons per year (current level) → 48,000 tons per year (final target)
Type: Chips → Fine-grained chips
Commencing time: October 2010 → June 2015: The quantity used was increased.

Oita Steelworks
Power generation facilities: Pulverized coal power generation (330MW)
Quantity used: 12,000 tons per year
Type: Chips
Commencing time: December 2014 (The planned quantity has been used since February 2015.)
Phase 2, Step 1 (FY18-22) Initiatives

【(1) Technologies to reduce blast furnace CO₂ emissions】
Prospects for highly feasible technologies for reducing blast furnace CO₂ emissions by about 10% will be acquired. Test operations for “full-circumference tuyere blowing” through partial modification of an actual blast furnace will be carried out after the start of Phase II, Step 2 (in FY 2023) while paying attention to the development of technologies for reducing CO₂ emissions. These test operations are expected to contribute to achieving the above target.

*The test blast furnace will be used continuously until FY 2022, aiming to develop new basic technologies to improve the efficiency of the use of hydrogen and expand hydrogen-reduction steelmaking operations.

【(2) Technologies to separate and collect CO₂ from blast furnace gas】
Efforts will be made to achieve technologies that make it possible to separate and collect CO₂ at a cost of 2,000 yen per ton of CO₂, hoping to achieve a CO₂ separation and collection energy use of 1.6 GJ per ton of CO₂. These are expected to contribute to developing technologies to reduce CO₂ emissions by about 20%.

(a) Technology for reducing blast furnace CO₂ emissions
(b) Technology for collecting CO₂ from blast furnace gas

CO₂ separation/collection

Unused sensible/exhaust heat

CO₂ storage*

Modified coke oven gas (hydrogen amplification)

Hydrogen gas

Blast Furnace

Coke Oven

Coke Oven Gas (COG)

Blast furnace gas (BFG)

Hydrogen reduction

CO₂ reduction target is about 30%

* assumptions are that an international equal footing is established and the necessary social infrastructure is created, including the site selection and establishment of a storage facility for government-led carbon capture and sequestration programs. Targets will be reexamined if these conditions are not fulfilled.
Overview of results in FY 2019

(1) Development of technologies to use hydrogen at blast furnaces
- As for development of technologies to reduce blast furnace CO₂ emissions, a main development issue under Phase II, Step1 from FY 2018 to FY 2022 (the first phase of practical development), test facilities that combine a test blast furnace with chemical absorption facilities were used to promote base technology development with a view to scaling up the tests.

(2) Development of technologies to separate and collect CO₂ from blast furnace gas
- As for development of technologies to separate and collect CO₂ from blast furnace gas, studies were conducted to further improve the performance of absorbents, which is already at the top level in the world, aiming to achieve technologies that make it possible to separate and collect CO₂ at a cost of 2,000 yen per ton of CO₂ or lower.

Source: The FY 2019 activity report of the Japan Iron and Steel Federation (JISF)
化石化資源依存からの脱却（再生可能エネルギー由来の電力や水素の活用）

水素還元製鉄技術等による「ゼロカーボン・スチール」の実現

【目標】
- 2050年以降のできるだけ早い時期までに、現在の高炉法による鋼鉄製造と同等のコストで「ゼロカーボン・スチール」を実現する水素還元製鉄技術等の開発を行う。実用化には、2050年の水素コスト（プラント引渡しコスト）20円/Nm³という目標をさらに下回る水準でCO₂フリー水素が安定的かつ大量に供給されることが必要。世界のCO₂削減量は約38億トン。1）

【技術開発】
- 「ゼロカーボン・スチール」の実現には長期的な研究開発が必要であるため、現行の高炉法における低炭素化、省エネルギー対策も重要となる。そのため、COURSE50やフェロコース技術の開発を引き続き行い、2030年度の実用化を目指す。
- COURSE50及びフェロコースの開発で得られる知見を足掛かりとして、「ゼロカーボン・スチール」の実現に向けた更なる革新技術を検討する。このため更なる革新技術に関するFS事業を実施し、高炉法による水素還元の拡大技術（COURSE50技術の拡大）、直接還元法による水素還元製鉄技術、CCUS等の技術開発や实用化における諸課題の抽出等を行う。当該結果を踏まえ、ナショナルプロジェクトによる支援の下に「ゼロカーボン・スチール」を実現する革新技術開発を進める。

（実施体制）
- 国際的な競争領域であるため、国内鉄鋼メーカーを中心とした連携により技術開発を進めると。
Efforts to Achieve Zero-Carbon Steel Production

- Nov, 2018: Release of “long-term vision for climate change mitigation- A challenge towards Zero-carbon STEEL-

- In June 2020, Nippon Steel, JFE Steel, and Kobe Steel, which are members of the JISF, and the Japan Research and Development Center for Metals (JRCM) were entrusted with a technology development project for realizing zero-carbon steel. The New Energy and Industrial Technology Development Organization (NEDO) had publicly invited applications for the project.

- This project aims to extract several prospective innovative technologies that focus mainly on decarbonization in steel production and to prepare a technology development roadmap for the steel industry of Japan. The JISF has determined to lead the world in undertaking technology development for the purpose of realizing zero-carbon steel by bringing forward initial plans under the above-mentioned long-term vision.
Commitment to JISF’s Low Carbon Society Phase II

Eco Process
Aiming 9 million-tons CO₂ reduction vs BAU emission in FY2030 by fully implementing state-of-the-art energy technologies

Eco Solution
Contribute worldwide by transferring the world’s most advanced energy-saving technologies to other countries (especially to developing countries) and increasing the use of these technologies. (Ca. 50 million tons of CO₂ reduction contribution in FY2013. Ca. 80 million tons of estimated CO₂ emission reduction contribution in FY2030)

Eco Product
By supplying the high-performance steel that is essential to create a low-carbon society, contributes to lowering emissions when finished products using this steel are used. (Ca. 26 million tons of CO₂ emission reduction contribution in FY2013. Ca. 42 million tons of estimated CO₂ emission reduction contribution in FY2030.)

Development of revolutionary processes (COURSE50)
Cut CO₂ emissions from production processes by about 30% by using hydrogen for iron ore reduction and collecting CO₂ from blast furnace gas. The first production unit is to begin operations by about 2030*. The goal is a widespread use of these processes by about 2050 in line with the timing of updates of existing blast furnace facilities.

Development of innovative ironmaking process (Ferro Coke)
Develop ferro-coke that can speed up and lower the temperature of the reduction reaction inside a blast furnace and create the associated operating process. Develop revolutionary technologies that can reduce energy consumption for pig iron production and permit the greater use of low-grade raw materials.
The 2030 goal for steel production processes is to use advanced technologies as much as possible to lower CO₂ emissions by 9 million tons compared with the volume of these emissions (BAU emission volume) expected from each production volume figure*1 (but excluding the improvement in the electricity coefficient).

### Actions

<table>
<thead>
<tr>
<th></th>
<th>Phase II 2030</th>
<th>Phase I 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Improve coke oven efficiency</td>
<td>About 1.3mn tons of CO₂</td>
<td>About 0.9mn tons of CO₂</td>
</tr>
<tr>
<td>(2) More efficient electricity generation</td>
<td>About 1.6mn tons of CO₂</td>
<td>About 1.1mn tons of CO₂</td>
</tr>
<tr>
<td>(3) More energy conservation</td>
<td>About 1.5mn tons of CO₂</td>
<td>About 1.0mn tons of CO₂</td>
</tr>
<tr>
<td>(4) Waste plastics*2</td>
<td>2.0mn tons of CO₂</td>
<td>–</td>
</tr>
<tr>
<td>(5) Develop and use revolutionary technologies*3</td>
<td>About 2.6mn tons of CO₂</td>
<td>–</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>9mn tons of CO₂</strong></td>
<td><strong>3mn tons of CO₂ + Waste plastics*4</strong></td>
</tr>
</tbody>
</table>

These reductions do not include the effect of changes in the electric power emissions coefficient.

### BAU Emissions and Target

*1 These targets are based on total crude steel production of 120 million tons in Japan, plus or minus 10 million tons. Emission reductions may be more or less than the anticipated range if there is a significant change in production volume. If there is a significant change, the suitability of the BAU figure and emission reduction will be reexamined in accordance with the actual production level.

*2 Points concerning increasing the use of waste plastics and other waste materials

  a. Awaiting results of studies concerning a Japanese government review of the container, packaging and plastic recycling system and other related items; may be reviewed (target reduced) if there is no outlook for growth in the waste materials handling capacity of the steel industry by FY2030 in relation to the actual FY2005 capacity.

  b. In addition, for the reduction target incorporated in the FY2020 target, awaiting results of a Japanese government study of the recycling system; may be reviewed (target reduced) if there is no outlook for growth in waste materials handling capacity by FY2020 in proportion to the above target.

*3 For the development and use of revolutionary technologies, assumptions are that (a) technologies will be in use in FY2030 and (b) the use of these technologies is economically feasible. In addition, for COURSE50, assumptions are that an international equal footing is established and the necessary social infrastructure is created, including the site selection and establishment of storage facility for government-led carbon capture and sequestration programs. Targets will be reexamined if these conditions are not fulfilled.

*4 Within the target for the 5 million ton reduction in CO₂ emissions in FY2020, the primary focus is on a 3 million ton reduction in CO₂ emissions by steelmakers’ own initiatives for efficient use of energy and other ways. Concerning the collection of waste plastics and other ways, only an increase in the collected volume compared to FY2005 is counted as the amount of reduction in emissions.
Steel Production Processes and Development and Use of Energy Conservation Technologies

Coal moisture control equipment
Coke dry quenching equipment
SCOPE21
Reuse of waste plastics

Coal

Coke oven

Iron ore

Pellet plant

Blast furnace

Pulverized coal input
Top pressure recovery turbine HS
(Dry/low-pressure loss furnace top pressure recovery turbine (TRT))
Exhaust heat recovery
Reuse of waste plastics

Oxygen

OG boiler
Kalina cycle power generation

BFG

LDG

LD converter gas
Recovery of latent heat and sensible heat

Pulverized coal

Torpedo car

Input of hot slab
Direct rolling

COG

Bloom

Slab

Electric power plant

High-efficiency power generation
ACC USC

Fuel heavy oil

Electric power plant

Fuel

High-efficiency power generation

Kalin cycle power generation

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(Reference) Change in Product Mix for Downstream Evaluations

- 31. Other specialty steel*
- 30. High tensile strength steel*
- 29. Piano wire
- 28. Free cutting steel
- 27. Bearing steel*
- 26. Spring steel
- 25. Structural alloy steel*
- 24. Structural alloy steel
- 23. High-speed steel
- 22. Tool steel
- 21. Carbon tool steel
- 20. Stainless steel*
- 19. Seamless pipes, specialty steel
- 18. Seamless pipes, stainless
- 17. Other pipes, ordinary steel
- 16. Seamless pipes, ordinary steel
- 15. Other metal coated sheets
- 14. Galvanized sheets, export high tensile strength steel
- 14. Galvanized sheets
- 13. Tin-free steel
- 12. Tinplate
- 11. Cold-rolled electrical sheets
- 10 Cold-rolled sheets
- 9 hot-rolled strips, export high-tensile strength steel
- 9 hot-rolled strips
- 8 Steel sheets, medium/thin
- 7 Heavy plates, export high-tensile strength steel
- 7 Heavy plates
- 6 Special steel wire rod
- 5 Ordinary wire rod, bar-in-coil
- 4 Bars
- 3 Sections
- 2 Steel plates and piling
- 1 Rails, tires and rolled wheels
- 0 Net exports of semi-finished products